# NOTES ON THE BIOLOGY OF *VARANUS CAUDOLINEATUS* AND *VARANUS GILLENI*

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The arboreal pygmy goannas *Varanus caudolineatus* (Fig. 1) and *Varanus gilleni* (Fig. 2) are morphologically and ecologically fairly similar, and although allopatric, they have sometimes been confused. Very little has been reported concerning either species. Boulenger described *caudolineatus* in 1885 on the basis of a single specimen from Champion Bay, W.A. The literature on this species is extremely scanty, and so far as I can ascertain, it has been mentioned only by Werner (1909), Mertens (1942, 1958), and Glauert (1961). No-one has alluded to its arboreal habits. Lucas and Frost described *gilleni* in 1895 and later provided an accurate colour plate of this species (Lucas and Frost, 1896). These workers reported that one of their two specimens was found in a desert she-oak tree *(Casuarina decaisneana)*, and the other in a gum tree. Waite (1929) indicates that *gilleni* occurs in the hollows of myall trees in South Australia, and Cogger (1962) reports that *gilleni* is "usually found in close association with mulga trees." Apart from these observations, the literature on *Varanus gilleni* has been largely re-iterative; a point frequently stressed is that the claws of *gilleni* are more strongly curved than those of the terrestrial pygmy goanna, *Varanus eremius*.

The present paper is based upon all the specimens in the Australian state museums plus material in my own collection.† During the course of this investigation, I examined 92 specimens of *caudolineatus* and 104 of *gilleni*.

Fig. 3 is a spot map showing all localities specific enough to be plotted. Closed symbols represent records based upon specimens I have examined, open ones literature records and those based upon specimens I have not seen. All localities are listed below, using the following abbreviations: AM (Australian Museum), NMV (National Museum of Victoria), SAM (South Australian Museum), WAM (Western Australian Museum), and ERP (personal collection). Specimens reported in the literature are listed with the locality and the appropriate reference.

## *Varanus caudalineatus*

*Distribution:*

(All localities in Western Australia): WAM R22995, R25883 (Ajana); WAM R19789-90, R28290 (Albion Downs); ERP-12 specimens (16 m. S. Atley); WAM R7279 (Cadoux); WAM R28394, R28955-56 (Coordewandy Stn.); WAM R13857, R19600 (Cosmo Newberry); WAM R14918 (7 m. S. Cue); NMV R920-24 (Day Dawn, Murchison Goldfields); WAM R22652 (Field's Find); SAM R6122-23 (Gascoyne district); WAM R26320 (Greenough); WAM R13362, R26068-70 (Jigalong Mission); WAM R14240 (Kalgoorlie); WAM R20241 (near Kangiangi HS); WAM R19441 (Kathleen Valley); WAM R3903 (Lake Nabberu); WAM R3415-16, R3423, R23908, R23910 (Laverton); WAM R14917 (17 m. NE. Marillana); WAM R5048 (Marrila Station, via Carnarvon); WAM R7378-79 (Meekatharra); NMV D1777 D1783 (Middalya); WAM R15785-89 (Mileura); NMV D7622 (Mingenew); NMV D3558; WAM R10611 (Minilya); WAM R29111 (20 m. S. Mount Magnet); WAM R17681 (Mt. Margaret Mission); WAM R12218 (Mundiwindi); NMV D1696 (Murchison River); WAM R330-31, R4933-34, R10812

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† Now lodged in the Los Angeles County Museum of Natural History.

Fig. 1—Subadult female *Varanus caudolineatus* from 16 miles south of Atley HS, W.A. The dorsum is buffy grey-brown with scattered spots of darker brown. The ground colour of the tail is grey with markings of dark-brown; proximally the tail is spotted, distally it becomes longitudinally striped. Head greyish, speckled with numerous small dark-brown spots, and with a dark-brown stripe behind the eye. Ventrally a pale cream colour with some speckling of small dark-brown spots, especially beneath the throat.

(Nannine, via Meekatharra); WAM R13137 (No. 5 tank, NW Hwy; 150 m. N. Northampton); AM R3057, R12460 ("Perth"); WAM R21149 (22 m. N. Sandstone); WAM R21150 (32 m. SW. Sandstone); WAM R13711 (Shark Bay turn-off, Great Northern Hwy.); WAM R4288 (Tambrey HS); WAM R12159 (Tardun); WAM R25149 (2 m. SE. Turee Creek); WAM R27231 (Wanjarri Stn., Kathleen Valley); WAM R28028 (Weld Spring); WAM R21137 (15 m. SW. Wiluna); WAM R21138-39 (44 m. SW. Wiluna); WAM R3818 (Wurarga); WAM R1191, R4732, R4733, R8168, R22870 (Yalgoo); SAM R3448 (Yande Yarra); WAM R21100 (20 m. NE. Yelma Hstd.); WAM R21178-81 (7 m. SW. Youanmi); ERP 10606 (35 m. SW, Youanmi). Literature records: Champion Bay, Nannine Co., Cadoux, and Tardun (Mertens, 1958).

## *Varanus gilleni*

*Distribution:*

NORTHERN TERRITORY: AM R11906, NMV D161 (Alice Springs); NMV D4920-23, D549, D4973, D4975, D5622, D5624-25, SAM—(unregistered) (Barrow Creek); SAM R2058 (West of Barrow Creek); AM R13940 (Camp 16, Simpson Desert Expedition); NMV D223, D8014 (Central Australia); NMV D2706 (Charlotte Waters); SAM R1613 (Finke River); NMV D11759 (between Glen Edith and Deering Creek); AM R10857 (Hermannsburg); SAM R312 (Macdonnell Ranges); WAM R24437 (10 m. S. Ewaninga; 31 m. SSE. Alice Springs); SAM R3374 (Tanami); AM R2141-42; SAM R6013. R6092, NMV D38-39, 41-46, D71-76, D2919, D2927, D2940, D2942, D5638-41 (Tennant Creek); NMV D5099 (lat. 19deg, long. 132deg); SAM R3257 (Yuendumu). Literature records: Finke River, Hermannsburg (Loveridge, 1934); South's Range (Loveridge, 1938); Camp 16, Simpson Desert

Expedition (Kinghorn, 1945); Ayer's Rock (Mertens, 1958); near Kimai Well (Thomson and Hosmer, 1963).

SOUTH AUSTRALIA: NMV D11760 (S.A. near Charlotte Waters); SAM R604 (between Everard and Musgrave ranges); SAM R996 (Kingoonya); SAM R1176 (Lake Phillipson); SAM R1313 (Mt. Arden); AM R17566-68, 17608, 17652, 17940-1, 17609, 18493, 20574 (Mt. Davies, Tomkinson Ranges); SAM R7596-97 (Musgrave Park); SAM R2349 (between Ooldea and Tallaringa); SAM R956 (Stuart's Range); NMV D2978, D3004, D3012, D3046 (Overland Railway); AM R17532-33 (Tomkinson Ranges). Literature records: between Everard and Musgrave Ranges, Wantapella Swamp (Zietz, 1915).

WESTERN AUSTRALIA: WAM R28814 (178 m. E. Carnegie HS); SAM R5297-98 (Giles); WAM R28027 (Indujan Creek, La Grange); WAM R28864 (48 m. SW. Mt. Beadell, Sutherland Range); ERP 12416 (5 m. W. Neale Junction); WAM R26714 (presumably West Kimberley district); SAM R3439 (Pilgangoora Well); WAM R19598-99, R20608, R22021-22, R22211-12 (Warburton Mission); WAM R14653-55, R22007 (Warburton Ranges); WAM R15179 (5 m. NNW Warburton Mission); WAM R21000-01 (6 m. SE. Warburton Mission); WAM R15706-08 (20 m. E. Warburton); WAM R14656-57 (New Bore, 28 m. NW. Warburton Mission); SAM R1756 (Wells 49-50, Canning Stock Route); WAM R3970, R3995, R8715 (Well 44, Canning Stock Route); SAM R1758 (Wells 39-51, Canning Stock Route).

The stippled areas indicate the suggested limits of distribution. As may be seen from the map *caudolineatus* is strictly a Western Australian form, whereas *gilleni* has a more "central" distribution. Their ranges taken together approximate that of *Varanus eremius* (Pianka, 1968) and more or less coincide with the limits of the Australian deserts. I consider it probable that further collecting will decrease the already narrow gap between the

Fig. 2—Adult male *Varanus gilleni* from 5 miles west of Neale Junction, W.A. The dorsal ground colour is a rich golden brown, with deep maroon coloured irregular cross bars. The patterning of dark-brown lines on top of the head is diagnostic. Tail and sides are predominantly greyish, with dark brown spots laterally, becoming bands dorsally and stripes distally on the tail. Ventrally cream-coloured with some speckling of fine grey spots on the throat.

ranges of these two species even further, and that their ranges will eventually be found to contact each other. Such cases of abutting allopatry in closely related species have considerable inherent ecological interest because their very existence implies that both species are utilizing the same "niche"; moreover, abutting allopatry suggests that each species is better adapted to exploit the area in which it occurs than the other species. One might thus predict that although two such species should have grossly similar autecologies, there should also be subtle but ecologically important differences between them, giving each species an advantage over the other within its own geographic range and particular habitat.

Although the usual habitat of *V. caudolineatus* is healthy mulga country, where it takes refuge under loose bark and in small hollows of mulga trees *(Acacia aneura)*, the species has also been taken from eucalypt hollows and the rock crevices of exfoliating granitic outcrops. It is not unusual for tree-dwelling lizards to also exist on rocks; this phenomenon occurs in a wide variety of lizard species *(Gehyra variegata, Oedura marmorata, Egernia depressa, Ablepharus boutonii, Varanus tristis,* and others). The apparent equivalence of trees, with loose bark and hollows, to exfoliating granite, with rock crevices and cracks, is readily understandable; both substrates would appear to offer comparable foods, basking sites, and protection from the elements and predators. *V. gilleni* has not yet been reported from rocky habitats, but it would not be surprising if it were discovered in such a situation.

*Varanus gilleni* has been taken under loose bark on desert she-oaks *(Casuarina)*, from gum tree hollows *(Eucalyptus)*, and

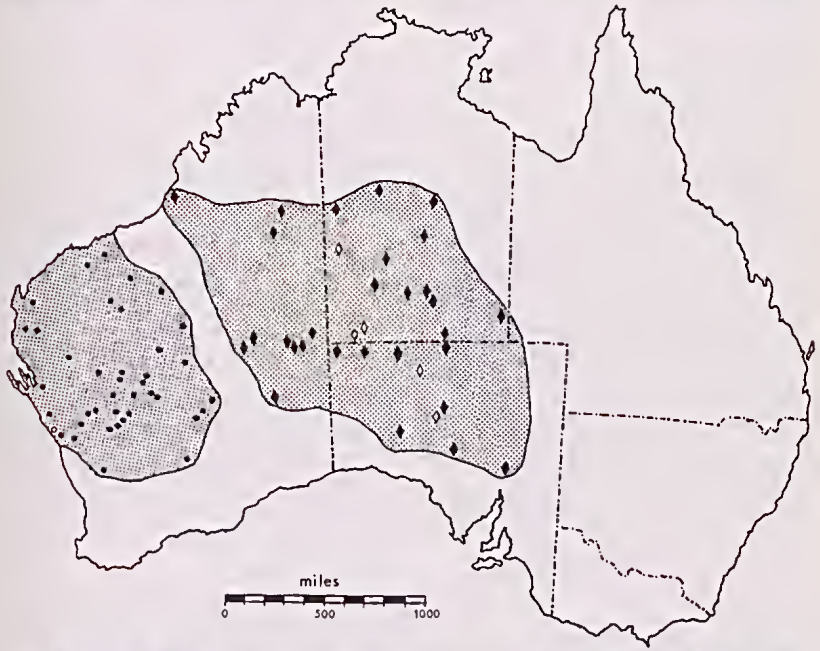


Fig. 3—The geographic distribution of *Varanus caudolineatus* (circles) in Western Australia, and *Varanus gilleni* (diamonds) in central Australia, illustrating allopatry in these lizard species. See text.

in the hollows of both mulga and myall trees *(Acacia)*. Where it occurs in association with desert she-oaks, at least, *V. gilleni* exists in spinifex habitats on fairly sandy soils (generally classified as sandplains). In this respect the habitat of *caudolineatus* and *gilleni* can differ substantially, for *caudolineatus*, to my knowledge, is never found in spinifex habitats or on true sandplains. These facts suggest that the natural boundary between the sandy deserts and the harder soils of the Pilbara-Hamersley region may ultimately prove to be the boundary between the geographic ranges of the two species.

There is a distinct size difference between the two species, with *gilleni* being larger (66 to 151 mm. snout-vent, average 112.5 mm.) than *caudolineatus* (60 to 127 mm. snout-vent, average 100.1 mm.).

Dr. G. M. Storr allowed me to examine the stomach contents of all the specimens of *gilleni* and *caudolineatus* lodged in the W.A. Museum. Tables 1 and 2 list the results of this examination

TABLE 1.—SUMMARY OF STOMACH CONTENT DATA FOR VARANUS GILLENI (N=25). 20 STOMACHS WERE EMPTY. VOLUMES MEASURED IN CUBIC CENTIMETRES.

| FOOD ITEM | NUMBER | VOLUME | FREQUENCY |
|---|---|---|---|
| Grasshoppers | 3 | 1.6 | .08 |
| Gehyra variegata | 4 | 9.2 | .08 |
| Heteronota binoei | 1 | 0.6 | .04 |

TABLE 2.—SUMMARY OF STOMACH CONTENT DATA FOR VARANUS CAUDOLINEATUS (N=78). 44 STOMACHS WERE EMPTY. VOLUMES MEASURED IN CUBIC CENTIMETRES.

| FOOD ITEM | NUMBER | VOLUME | FREQUENCY |
|---|---|---|---|
| Centipedes | 2 | 1.2 | .026 |
| Spiders | 6 | 3.0 | .077 |
| Cicadas | 1 | 0.2 | .013 |
| Grasshoppers | 9 | 3.4 | .102 |
| Roaches | 11 | 4.4 | .128 |
| Moths | 1 | 0.3 | .013 |
| Caterpillars | 4 | 2.7 | .038 |
| Unidentified Insects | 6 | 0 2 | .077 |
| Gehyra variegata | 9 | 8.6 | 077 |
| Rhynchoedura ornata | 1 | 1.2 | .013 |
| Triodia seed head | 1 | 0.1 | .013 |
| Unidentified partially digested material | | 0.3 | |

including specimens in my own collection. Although the sample size for *gilleni* is small, these data indicate that a major food item of both species is *Gehyra variegata*, a widespread arboreal gecko that spends the daylight hours under loose bark, in tree hollows, and in rock crevices. The stomachs of several of the smaller *caudolineatus* and one small *gilleni* contained only apparently freshly autotomized *Gehyra* tails; perhaps some small individuals "learn" to break tails off prey otherwise too large to be subdued. It is noteworthy that both *gilleni* and *caudolineatus* occasionally capture ground dwelling geckos, as evidenced by the *Heteronota binoeii* and *Rhynchoedura ornata*, respectively. The only other item in the diet of the *gilleni* examined was large grasshoppers, also an important component of the diet of *caudolineatus*. It would thus appear that these two pygmy goannas have roughly similar feeding ecologies. However, the average size of the prey items recorded is considerably smaller in *caudolineatus* (0.55 cc.) than in *gilleni* (1.42 cc.). This is probably a direct reflection of the smaller head size of *caudolineatus*.

Examination of the gonads of the specimens dissected suggests certain tentative conclusions. Testes volumes of the 44 male *caudolineatus* examined were largest during July and August; those of the 18 male *gilleni* were largest during September and October. The data are scanty, but might be an indication that *caudolineatus* breeds earlier than *gilleni*. Only 5 female *gilleni* were available for examination and none had large ovarian or oviducal eggs; hence nothing can be said about clutch size or egg

laying in this species. Of the 33 female *caudolineatus* examined, 7 contained enlarged ovarian eggs (over 3 mm. in diameter); the number of enlarged follicles per female varied from 3 to 6, with a mode of 4. One female contained five 13 mm. oviducal eggs (unfortunately, there is no date of collection for this specimen). However, a female with enlarged oviducts was collected on 30 December 1967. Hence there is evidence that *caudolineatus* females lay 4-5 eggs during December.

Both species probably have similar predators. A large *V. caudolineatus* (about 90 mm. snout-vent) was found in the stomach of a 276 mm. *Varanus gouldi*. Another attempted predation was observed in the Great Victoria Desert. In the centre of a graded track, my wife and I came upon a small (about 200 mm. snout-vent length) *Varanus gouldi* which had in its jaws by the nape of the neck a large male. *V. gilleni* (150 mm, snout-vent length). The *gilleni* was wrapped around the *gouldi* struggling to twist itself free. Our intrusion instigated the predator to run away dragging its prey. Other natural predators would no doubt include raptors and large snakes.

Because most of the specimens of these two pygmy goannas in museum collections were taken while inactive (usually they are found under bark or within hollows), it is difficult to derive much information beyond basic habitat requirements about their behavior and ecology from such records. For the same reasons, it is nearly impossible to determine seasonal activity patterns from museum records of the months of collection. I have no information on *gilleni* beyond that already presented. We were, however, able to make some observations on *caudolineatus*. Repeated sampling on the same area over an entire year suggests that *caudolineatus* has a strongly seasonal activity pattern. The numbers of individuals known to be active which were taken during different months were: November (2), December (3), February (7), and March (1). These data coincide reasonably well with the breeding-egg laying season suggested earlier. Times of collection of these active lizards varies from 1000 to 1620 hours with a mean of 1300 (sample size=13). Body temperatures of 10 active individuals range from 34.0 to 40.8 with a mean of 37.8°C. Only 3 of these 13 active *caudolineatus* were on the ground when first sighted. Of the 10 which were above ground, one was on a termite mound, 2 were on dead mulga fenceposts, 5 on mulga tree trunks, and 2 on eucalypts. The height above ground varied from about 125 mm. to nearly 2 meters, with most about a meter off the ground.

In conclusion, it may be asserted that the habitats and diets of both these pygmy goannas are generally similar. However, several notable differences exist: (1) *Varanus gilleni* occurs in association with *Casuarina* and in sandplain habitats, which appear never to be utilized by *V. caudolineatus*, (2) *gilleni* is a larger animal and has a larger head than *caudolineatus*, and (3) preliminary indications are that *gilleni* takes larger prey, on the average, than *caudolineatus* (this fact is probably related to 2, above). These differences may provide clues to the particular ways in which each species is competitively superior to the other within its own geographic range.

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## *OEDURA RETICULATA,*
## A NEW VELVET GECKO FROM SOUTH-WEST WESTERN AUSTRALIA

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The gekkonid genus *Oedura* oeeurs in all mainland States with its greatest radiation in Eastern Australia in the New South Wales-Queensland border region. The genus has been the subjeet of reeent systematie study (Cogger, 1957; Bustard, 1966, 1967, and in press) and in the eourse of this work I found, in Museum eol-leetions, a number of speeimens of an undeseribed Western Aus-